625-CD-021-001

EOSDIS Core System Project

Flight Operations Segment (FOS) Release B Training Material for the ECS Project

January 1998

Raytheon Systems Company
Upper Marlboro, Maryland

Flight Operations Segment (FOS) Release B Training Material for the ECS Project

January 1998

Prepared Under Contract NAS5-60000
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RESPONSIBLE OFFICE

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Preface

This document is a contract deliverable with an approval code of 3. This document is delivered to NASA for information only, but is subject to approval as meeting contractual requirements.

This document represents the ECS Flight Operations Team (FOT) Training Material for the FOS Release B delivery. This document will be modified to reflect the final FOT Training, AM-1 Spacecraft Manufacturer Training, and AM-1 Instrument Operations Team (IOT), that is currently scheduled to occur in March 1998.

Any questions should be addressed to:

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Abstract

The ECS FOS Training Material document (DID 625/OP3) addressed the training material required to qualify the ECS FOT for operations of FOS Release B, and the AM-1 spacecraft. The ECS FOS Training Materials described in this document were designed to train and certify ECS Flight Operations Team (FOT) members supporting the AM-1 project.

AM-1 Spacecraft specific training will be provided by the Spacecraft manufacturer, and Instrument Operations training will be provided to the FOT by the Instrument Operations Teams. The training material addressed in this document is related to the FOS Release B specific design components and performance, and does not include training on management and personal development. Note that at the time of publication the FOT has not completed training for the AM-1 mission. Initial FOS training was conducted in November 1997. Final FOS training is scheduled for March 1998. Final FOS training will be combined with FOT training from the AM-1 spacecraft manufacturer, and the AM-1 IOTs.

Keywords: FOS; FOT; Flight Operations; Training.

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1. Introduction

1.1 Identification

The ECS Training Material, Contract Data Requirements List (CDRL) Item 129, whose requirements are System Data and Information System (EOSDIS) Core System (ECS), Contract (NAS5-6000).

The ECS Certification Plan, Contract Data Requirements List (CDRL) Item 130, whose requirements are specified in Data Item Description (DID) 626/OP1, is a required deliverable under the Earth Observing System Data and Information System (EOSDIS) Core System (ECS), Contract (NAS5-6000).

1.2 Scope

The FOS Release B Training Material is part of the overall ECS Training Program. This material defines Training Material as it relates to the operations of ECS FOS Release B by the ECS FOT. The scope of this plan will be limited to the FOS Release B software and hardware design for supporting AM-1 mission operations. Training Material on management and personal development will not be included in this document. This Training Material provides procedures and standards to operate the FOS and the AM-1 spacecraft.

This release of the training material does not include AM-1 Spacecraft specific training. AM-1 Spacecraft specific training will be provided by the spacecraft manufacturer. It is expected that the first draft of the AM-1 Spacecraft training materials will be available for review by ECS in March 1998. Current plans are to include AM-1 specific training when received as an appendix to this document.

This document is to be used by all members of the ECS FOT.

This document reflects the August 23, 1995 Technical Baseline maintained by the contractor Configuration Control Board (CCB) in accordance with ECS technical direction #11, dated December 6, 1994.

1.3 Purpose

The ECS Training Material will be used to prepare and certify ECS FOT staff to operate the FOS and AM-1 spacecraft. This material provides management and employees with a reference document for further technical training.

1.4 Status and Schedule

This material provides information about the FOS Release B training. Subsequent revisions will be submitted as needed.

1.5 Organization

This document is organized as follows:

Section 1: Introduction — This section presents the document identification, scope, purpose, status and schedule, and organization.

Section 2: Related Documentation — This section identifies parent, applicable and information documents associated with this plan.

Section 3: Classroom Training — This section describes the classroom training that has been conducted for FOS Release B, and describes classroom training that will be conducted in the future.

Section 4: Console Training — This section describes the console training that is being conducted for FOS Release B.

2. Related Documentation

2.1 Parent Documents

The parent document is the document from which this FOS Release B Training Material scope and content are derived.

423-41-01	Goddard Space Flight Center, EOSDIS Core System (ECS) Statement of Work

2.2 Applicable Documents

The following documents are referenced within this FOS Release B Training Material, or are directly applicable, or contain policies or other directive matters that are binding upon the content of this volume.

420-05-03	Goddard Space Flight Center, Earth Observing System (EOS) Performance Assurance Requirements for the EOSDIS Core System (ECS)
423-41-02	Goddard Space Flight Center, Functional and Performance Requirements Specification for the Earth Observing System Data and Information System (EOSDIS) Core System (ECS)

2.3 Information Documents

2.3.1 Information Documents Referenced

The following documents are referenced herein and, amplify or clarify the information presented in this document. These documents are not binding on the content of the ECS FOS Release B Training Material.

500-1002	Goddard Space Flight Center, Mission Operations and Data Systems Directorate (MO&DSD) NMOS Certification Program, 1/90
535-TIP-CPT-001	Goddard Space Flight Center, Mission Operations and Data Systems Directorate (MO&DSD) Technical Information Program Networks Technical Training Facility, Contractor-Provided Training Specification, 10/90

2.3.2 Information Documents Not Referenced

The following documents, although not referenced herein and/or not directly applicable, do amplify or clarify the information presented in this document. These documents are not binding on the content of the ECS FOS Release B Training Material.

601-CD-001-004	Maintenance and Operations Management Plan for the ECS Project
604-CD-001-004	ECS Operations Concept for the ECS Project: Part 1-- ECS Overview
604-CD-003-001	ECS Operations Concept for the ECS Project: Part 2A -- ECS Release A
605-CD-003-001	Operations Scenarios for the FOS: Release-A, Release-B
607-CD-001-002	Maintenance and Operations Position Descriptions for the ECS Project
609-CD-005-004	Flight Operation Segment (FOS) Operations Tools Manual
622-CD-003-001/ 626-CD-003-001	Flight Operations Segment (FOS) Release B Training and Certification Plan for the ECS Project
	Earth Observing System Mission Operations Concept Document, GSFC ESDIS/Omitron, Inc. (August 1996)
	EOC Facility Utilization Plan, GSFC ESDIS/Omitron, Inc. (September 1996)
	EOS AM-1 Mission Operations Concept, NASA/GSFC (May 1994)
	EOS Ground System Integration Plan (Preliminary), GSFC ESDIS/SES, Inc. (September 30, 1996)
	EOS Observing System Mission Operations Plan, GSFC ESDIS/SES, Inc. (September 1996)

3. Classroom Training

ESC FOT classroom training is used to help FOT members understand why they perform tasks in a prescribed manner and what to expect if they deviate from standard procedures. Interaction with a technically qualified instructor and other students provides FOT members with information not obtainable from on-the-job training or individual study. While classroom training encourages discussion, it is also characterized by formally defined objectives and documentation.

The classroom training sessions are defined for each position to provide background information Additionally, specific training pertinent to the position. Each session provides the employee the opportunity to take a quiz containing questions covering the key elements of the classroom session. Actual handouts from classroom training sessions are presented as Appendices to this document.

3.1 Course Objectives

The objectives of the ECS FOT training program is to prepare all FOT members to be in the highest state of readiness for the AM-1 launch and routine operations. The training is to prepare the FOT to handle contingency operations, and spacecraft emergencies.

3.2 Course Outlines

The following represents the outline for FOS Release B Training Material:

Agenda

- List the topics to be covered
- List the time allocated to each topic

Overview

- General subject overview
- How the individual topics relate

Vocabulary

- Glossary of terms
- Define terms used in this subject

Topics (to be repeated as many times as necessary to explain subject)

- Explain details
- Give examples

Exercise to re-enforce learning

Summary

State what has been learned

Define ways to apply training

Request feedback of training session

Where to obtain additional information

Other training sessions

List other sources manuals, and electronic sources that cover subject

3.3 Student Guides

Student Guides for FOT training sessions on the following training modules have been prepared:

Day in the life of AM-1 Normal Operations

Project Database

ECS Command Language

Display Page Generation

Activity Definer

Event Messages and Browsing

Logical Strings

Microprocessor Load Methodology

Inhibit ID

Trouble Tickets

The preceding Student Guides were the basis of ECS training sessions in November 1996. The training was presented to the FOT, NASA, AM-1 IOTs, IV&V, and other NASA EOSDIS support contractors by the ECS FOT. The Student Guides for these training modules are presented as Appendixes 1 through 10 of this document.

The FOT will be preparing Student Guides for the following training modules in presentation for the March 1998 training sessions:

Analysis Algorithms

Analysis Requests

Command Requests

Decision Support System Role in Operations

FDD Product Generation Flow

FOS Solid State Recorder Manager

Quick Analysis

Report Generator / Custom Reports

Safehold Recovery Methodology

SDVF Interface and Tools

ECL Procedures

Upon presentation of the additional training modules in March 1998 they will be included as additional appendices to this document, along with the material presented by the AM-1 spacecraft manufacturer, and the IOTs.

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4. Console Training

Console training provides the FOT members the opportunity to participate in training sessions within the actual work area. The main trust of the FOT Console Training are the planned exercises, simulations and test described in section 4 of this document. The console sessions have been predefined to include actual test cases for hands on operation and provide the employee the opportunity to interface with certified employees who can provide additional technical information. The console training, coupled with the comprehensive classroom training provides the employee with a sound basis for on the job training. The current FOT console training is identified in Exercises, Simulations, and Tests section of this document.

4.1 Operations Tools and Procedures to be Exercised

All FOS Tools, and FOT procedures will be exercised during the FOT training process. As additional AM-1 FOT procedures are developed in preparation for launch and on-orbit operation they will be exercised in the planned exercises, simulations, and tests.

4.2 Exercises Scenarios Exercises and Tests

The ECS approach to Exercises, Simulations, and Tests is to provide an interactive training environment for the FOT, i.e., the exercising of nominal and contingency procedures in as realistic an environment as possible. These simulations will exercise operator knowledge and skill in spacecraft operations, as well as mission preparedness. Anomaly identification (and resolution process), spacecraft launch and early orbit operation (nominal and contingency), on-orbit check-out and evaluation, network and inter-center communication, as well as launch management coordination will be exercised.

4.3 Ground Operations Exercises (GOEs), Spacecraft Operation Exercises (SOEs), and Integrated Simulations (ISs)

Simulations, Exercises and Test sequences for the ECS FOT are identified as GOEs, (SOEs, ISs. It should be noted that the main function of these simulations is to train the FOT, they are used to verify the readiness of the FOS, interfaces with and preparedness of internal and external organizations. The ECS FOT is the lead element for the team developing the GOEs, SOEs, and ISs, other team members are described below. Figure 4.3-1 displays the current ECS FOT AM-1 Training / Simulation schedule.

The GOEs and SOEs are the building blocks for the ISs. These operations exercises will concentrate on (but are not limited to) pre-launch, launch and acquisition activities. The GOEs and SOEs will train the Flight Operations Team (FOT) on how to implement nominal spacecraft and ground operation procedures, as well as exercise contingency procedures.

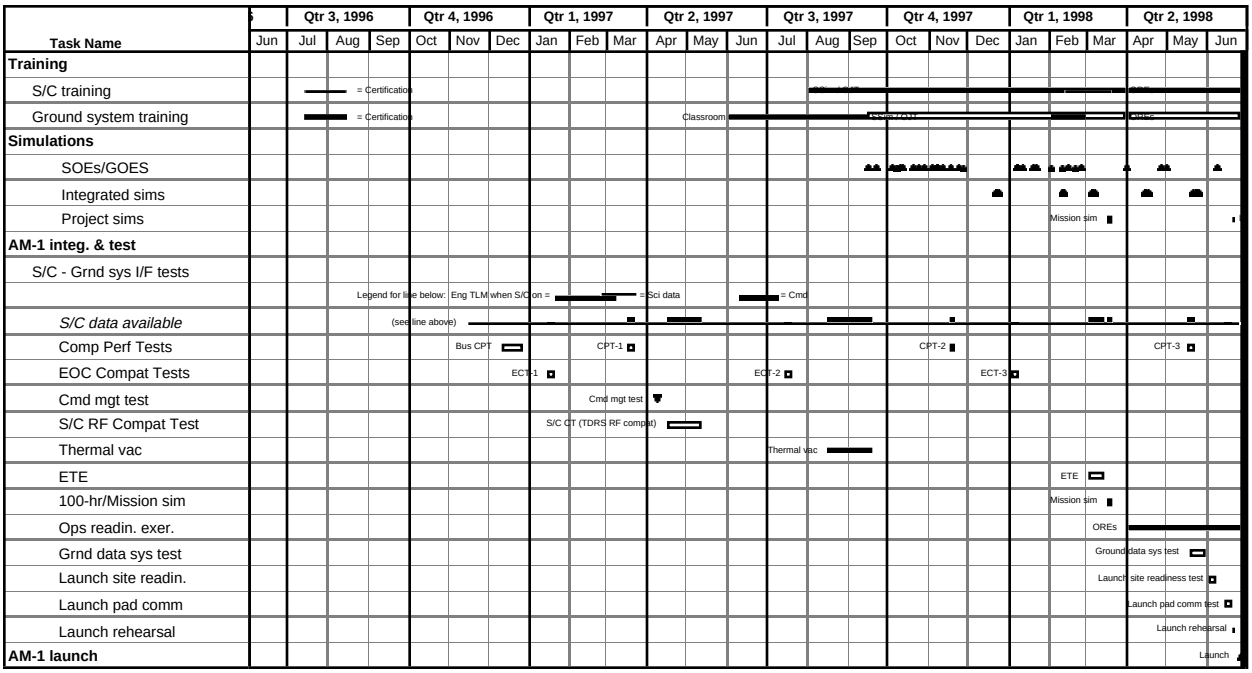


Figure 4.3-1. ECS FOT AM-1 Training/Simulation Schedule

The ISs are full scale spacecraft simulations that will follow planned mission activities and primarily focus on timelined events. ISs will include the FOT and all required ground system and spacecraft participants, such as (but not limited to) EOS Data and Operations System (EDOS), Advanced Spaceborne Thermal Emission and Reflection Radiometer Instrument Control Center (ASTER ICC), Flight Dynamics Division (FDD), Space Network (SN) and EOS Polar Ground Station (EPGS). For completeness, this section will also include a schedule of the overall AM-1 tests that are not addressed in this document.

4.4 Integrated Simulation Process

4.4.1 Simulation Script Development

Based on the objectives defined for a particular simulation, a spacecraft specific script to exercise the appropriate elements to achieve the desired objectives. The script is developed by the Simulation Team (ST), whose members will include the FOT, NASA, IPG and spacecraft manufacturer subcontractor, using the nominal mission timeline. Off-nominal conditions will be inserted into the training exercises. The Simulations Coordinator (SC) is the lead individual for each simulation.

4.4.2 Simulation Kick-Off Briefing

The SC conducts the IS kick-off briefing. At a minimum, the briefing will consist of the following information: simulation start and stop times, on console time, mission timeframe to be exercised, known simulator deficiencies, special simulation unique configurations, critical documentation revisions (e.g., current revision of procedures), and action item status (from previous simulations).

The SC may not always provide the information or briefing for a particular topic, but is responsible for coordinating to ensure the topic is addressed and an electronic version is provided to the participants. The first simulation kick-off briefing will provide more in-depth information regarding start up items (e.g., may provide a listing of voice communications available, a brief explanation of how anomalies are induced, etc.).

4.4.3 Simulation Set-Up

Each IS scenario will has its own unique control and operations requirements to insure the proper control channels and staffing for simulation operation are in place. The voice loops are identified for each simulation, on an as needed basis, and in coordination with the Simulations Training Coordinator (STC). The simulation voice loops will differ from the normal operations voice loops in that there will also be special simulation control loops from the SC to the supporting elements.

Voice and data flow channels will be tested prior to each simulation, under the supervision of the STC. The SC will start the simulation once all supporting elements are ready, as determined by the STC. The SC will announce the start of the simulation over the appropriate voice loops.

4.4.4 Simulation Deliverables

All IS participants will provide data 2 weeks before the formal simulation.

4.4.5 Simulation Execution

The SC, NASA Flight Operations Director (FOD) and STC will control the flow of the simulation timeline for each simulation. Data flow coordination will be performed via voice loop between the SC and the SS. Initial simulation start will be coordinated via voice loop between all participating areas. Telemetry flow will be in accordance with the timeline defined in the simulation kick-off briefing. The SC will control all data flow throughout the simulation. The simulation will be concluded when the defined timeline has been exercised or the FOD, STC, and the SC agree all objectives have been met. An announcement will be made on the loops that the simulation is concluded and will identify the starting time for the debriefing.

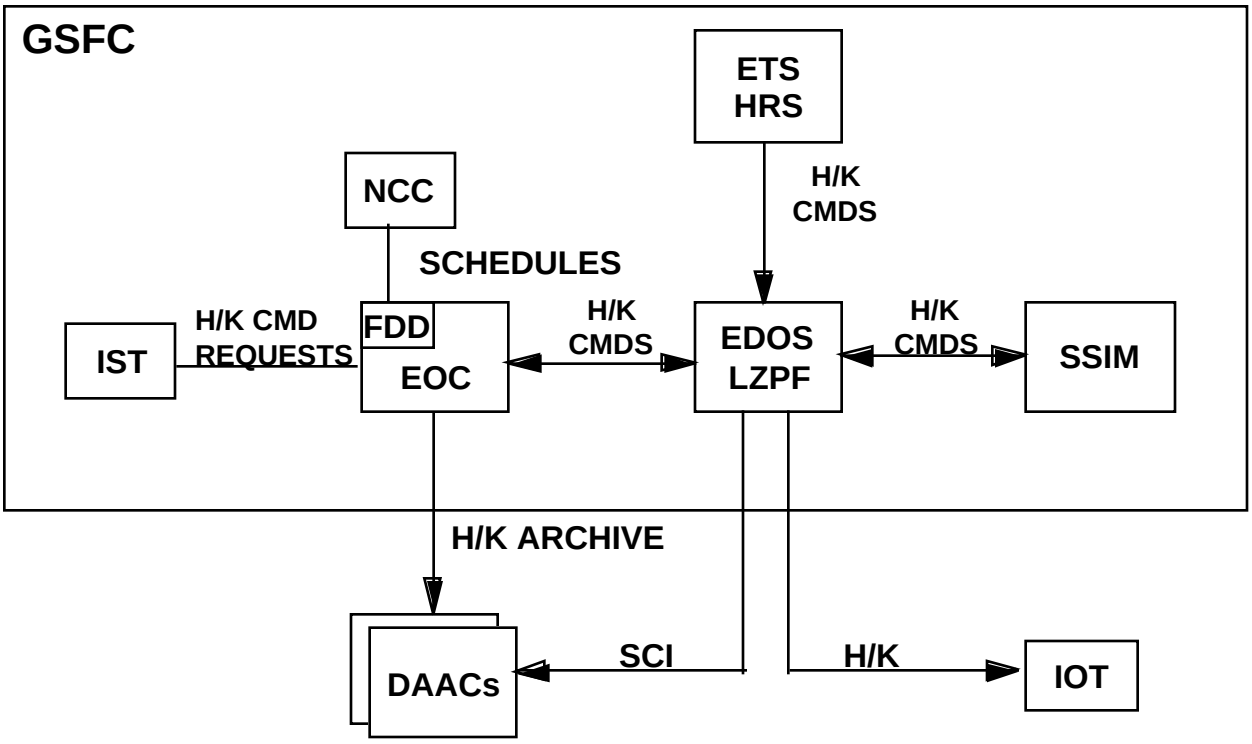


Figure 4.4.5-1. Generic Simulation Configurations

4.4.6 Summary Debrief

At the completion of each integrated simulation, the FOD, STC and the SC will conduct a simulation debrief. The debrief is designed to review the conduct and quality of the previous exercise, address operational issues and assign action items (where required) to improve operational procedures and/or processes.

4.4.7 Post Simulation Meeting

No earlier than 2 days following an integrated simulation debrief, a post simulation meeting will be held to discuss the successes and failures of the simulation. Identifying and prioritizing of action items, decisions to repeat particulars of the simulation and impacts to overall schedules will be the driving agenda items. The post simulation meeting will take place no later than 7 days after simulation completion, and representatives for all participants of the simulation are expected to attend.

4.4.8 Post Simulation Report

The SC will be responsible for issuing a written simulation debrief report. The report will include a synopsis of the period simulated, major issues identified in the debrief, list of the action items assigned, and details on unsuccessful activities.

4.5 Exercise Scenarios

4.5.1 Scenario Definition

Scenarios will follow planned mission activities, and will primarily focus on the major timeline events. There will be simulations that exercise the nominal procedures for these activities, and there will be training exercises (SOEs, GOEs) where malfunctions are inserted in the activity that are designed to exercise contingency procedures. When malfunctions are introduced, they will be inserted unexpectedly for the FOT, into the timeline. The FOT will treat them as actual mission anomalies and act accordingly.

4.5.2 Nominal Operations

These exercises will consist of simulation training activities for non-launch, routine spacecraft activities. Nominal operations exercises would include, but are not limited to, on-board recorder management, load/dump practices and time correlation.

4.5.3 Special Operations

Simulations of deployments, post-launch maneuvers and flight software patches are considered special operations. These exercises will familiarize the FOT with deployment sequences, on-board computer execution of pre-planned on-board commands, as well as deployment commands via real-time commands from the EOC. Simulations of orbit acquisition familiarize the FOT with applicable procedures, monitoring telemetry and verifying prerequisites which must be met prior to initiating orbit acquisition maneuvers.

4.5.4 Contingency Operations

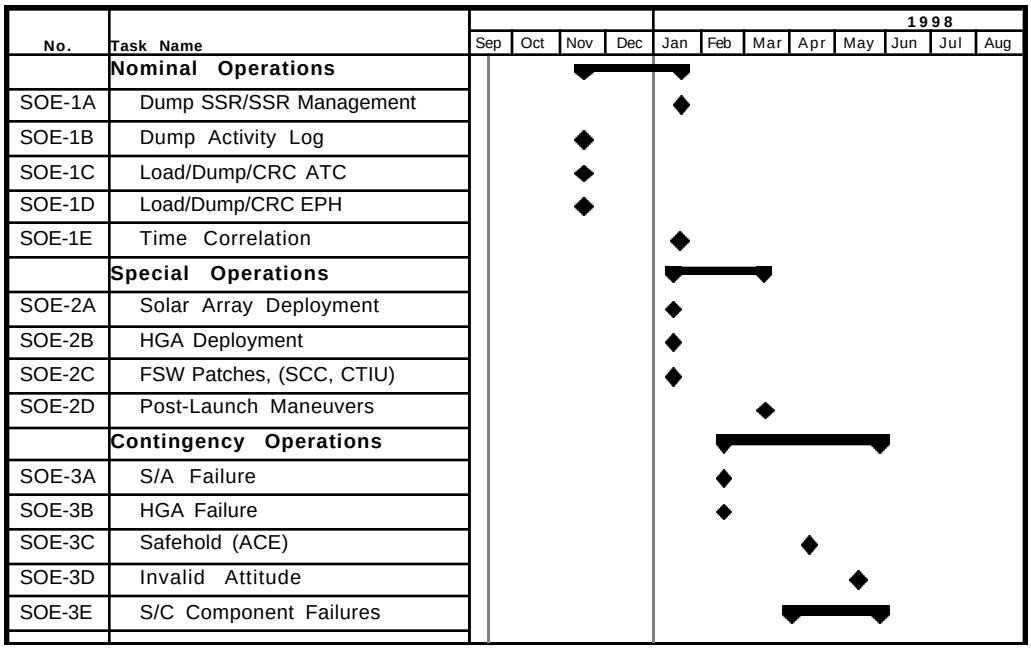
One of the prime purposes of simulations is to implement the off nominal or contingency operations procedures using tiger teams and exercising the chain of command. Operations management provides a generic plan to respond in real-time to significant anomalies detected during early on-orbit activities to be used during simulations as during on-orbit supports.

4.6 AM-1 Mission Specific Exercises, and Simulations Timeline

The timelines for all Operations Exercises and Integrated Simulations as well as schedule tables for the activities to be simulated and the participants expected to support the specific training scenarios. This appendix defines the specific operational exercises and integrated simulations, explaining what each of the training exercises are intending to accomplish. For completeness, this appendix will include the specific AM-1 simulator resources such as the Spacecraft Simulator (SSIM) and the EOSDIS Test System (ETS).

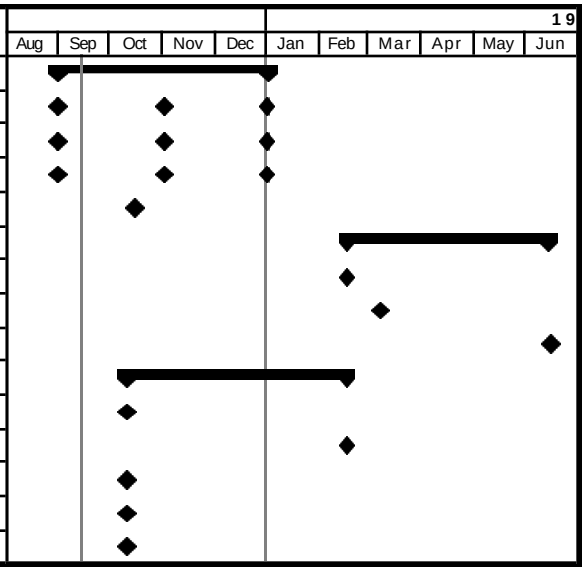
Please note that the following schedules are based on all known information at the time of publication for this document, and are subject to possible revision.

Simulations Schedule



No.	Task Name
	Nominal Operations
SOE-1A	Dump SSR/SSR Management
SOE-1B	Dump Activity Log
SOE-1C	Load/Dump/CRC ATC
SOE-1D	Load/Dump/CRC EPH
SOE-1E	Time Correlation
	Special Operations
SOE-2A	Solar Array Deployment
SOE-2B	HGA Deployment
SOE-2C	FSW Patches, (SCC, CTIU)
SOE-2D	Post-Launch Maneuvers
	Contingency Operations
SOE-3A	S/A Failure
SOE-3B	HGA Failure
SOE-3C	Safehold (ACE)
SOE-3D	Invalid Attitude
SOE-3E	S/C Component Failures

Figure 4.6-1. Spacecraft Operations Exercises [SOE]



No.	Task Name
	Nominal Operations
GOE-1A	Planning
GOE-1B	Scheduling
GOE-1C	**Command Management System**
GOE-1D	Real-time Operations Loads
	Special Operations
GOE-2A	Schedule Ground Station
GOE-2B	Maneuvers
GOE-2C	Launch Rehearsal
	Contingency Operations
GOE-3A	ACQ Blind, Late, Negative
GOE-3B	Ground Station Support
GOE-3C	RT Server Failover
GOE-3D	LAN Failover
GOE-3E	DS Failover

Figure 4.6-2. Ground Operations Exercises [GOE]

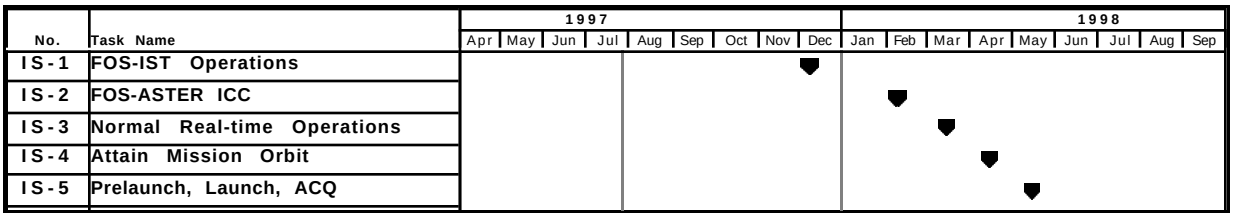


Figure 4.6-3. Integrated Simulations

SSIM Training Exercises

	Activity Simulated	Date	Participants	Simulation Requirements
	Normal Operations			
SOE-1A	SSR Management	1/98	1, 6, 14	SSIM
SOE-1B	Dump Activity Log	11/97	1, 6	SSIM
SOE-1C	Load/CRC and Dump/Compare ATC	11/97	1, 6	SSIM
SOE-1D	Load/CRC and Dump/Compare EPH	11/97	1, 6	SSIM
SOE-1E	Time Correlation Management	1/98	1, 6, 14	SSIM
	Special Operations			
SOE-2A	Solar Array Deployment	1/98	1, 6, 14	SSIM
SOE-2B	HGA Deployment	1/98	1, 6, 14	SSIM
SOE-2C	FSW MNGT (SCC, CTIU, SSST)	1/98	1, 6, 13, 14	SSIM
SOE-2D	Post-Launch Maneuvers	3/98	1, 6, 10, 14	SSIM
	Contingency Operations			
SOE-3A	Solar Array Deployment	2/98	1, 6, 14	SSIM
SOE-3B	HGA Deployment	2/98	1, 6, 14	SSIM
SOE-3C	Safehold Recovery (ACE)	4/98	1, 4, 6, 8, 14	SSIM
SOE-3D	Invalid Navigation	5/98	1, 6, 10, 14	SSIM
SOE-3E	S/C Component Failures	4/98-5/98	1,4,6,8, 14	SSIM

Participants column is: 1 = FOT (for *all* sims), 2=EBnet, 3=RF SOC, 4=IOTs, 5=TGT, 6=EDOS, 7=WOTS/EPGS, 8=ASTER ICC & JPL Gateway, 9=NCC, 10=FDD, 11=DAAC(s), 12 = GSIF, 13 = SDVF, 14=VF

Figure 4.6-4. Spacecraft Operations Exercises

	Activity Simulated	Date	Participants	Simulation Requirements
	Nominal Operations			
GOE-1A	Planning (3)	9/97 11/97 1/98	1,10 1,4,10 1,8,10	Run GOE-1A three times
GOE-1B	Scheduling (3)	9/97 11/97 1/98	1,10 1,4,10 1,8,10	Run GOE-2A three times
GOE-1C	Command Management	9/97 11/97 1/98	1,10 1,4,10 1,8,10	Run GOE-3A three times
GOE-1D	Normal R/T Ops	10/97	1, 6	ETS
	Special Operations			
GOE-2A	Schedule Ground Station	2/98	1, 7, 10	
GOE-2B	Maneuvers	3/98	1, 4, 6, 8, 9, 10, 14	SSIM
GOE-2C	Launch Rehearsal	6/98	All	SSIM
	Contingency Operations			
GOE-3A	AOS Blind, Late, Negative	10/97	1, 6, 14	ETS, SSIM
GOE-3B	Ground Station Support	2/98	1, 6, 2, 7	ETS, SSIM
GOE-3C	RT Server Failover	10/97	1	ETS, SSIM
GOE-3D	LAN Failover	10/97	1	
GOE-3E	DS Failover	10/97	1	

Participants column is: 1 = FOT (for *all* sims), 2=EBnet, 3=RF SOC, 4=IOTs, 5=TGT, 6=EDOS, 7=WOTS/EPGS, 8=ASTER ICC & JPL Gateway, 9=NCC, 10=FDD, 11=DAAC(s), 12 = GSIF, 13 = SDVF, 14=VF

Figure 4.6-5. Ground Operations Exercises

SSIM Integrated Simulations

	Activity Simulated	Date	Participants	Simulation Requirements
IS-1	FOS-IST Interactions, Normal Operations	12/97	1, 2, 4, 6	ETS
IS-2	FOS-ASTER ICC Interaction, Normal Operations	2/98	1, 2, 6, 8	ETS
IS-3	Normal Real-Time Operations	3/98	1, 2, 4, 6, 8,14	SSIM
IS-4	Attain Mission Orbit	4/98	1, 6, 10,14	SSIM
IS-5	Pre-launch, Launch, Acquisition	5/98	All	SSIM

Participants column is: 1 = FOT (for *all* sims), 2=EBnet, 3=RF SOC, 4=IOTs, 5=TGT, 6=EDOS, 7=WOTS/EPGS, 8=ASTER ICC & JPL Gateway, 9=NCC, 10=FDD, 11=DAAC(s), 12 = GSIF, 13 = SDVF, 14=VF

Figure 4.6-6. Integrated Simulations

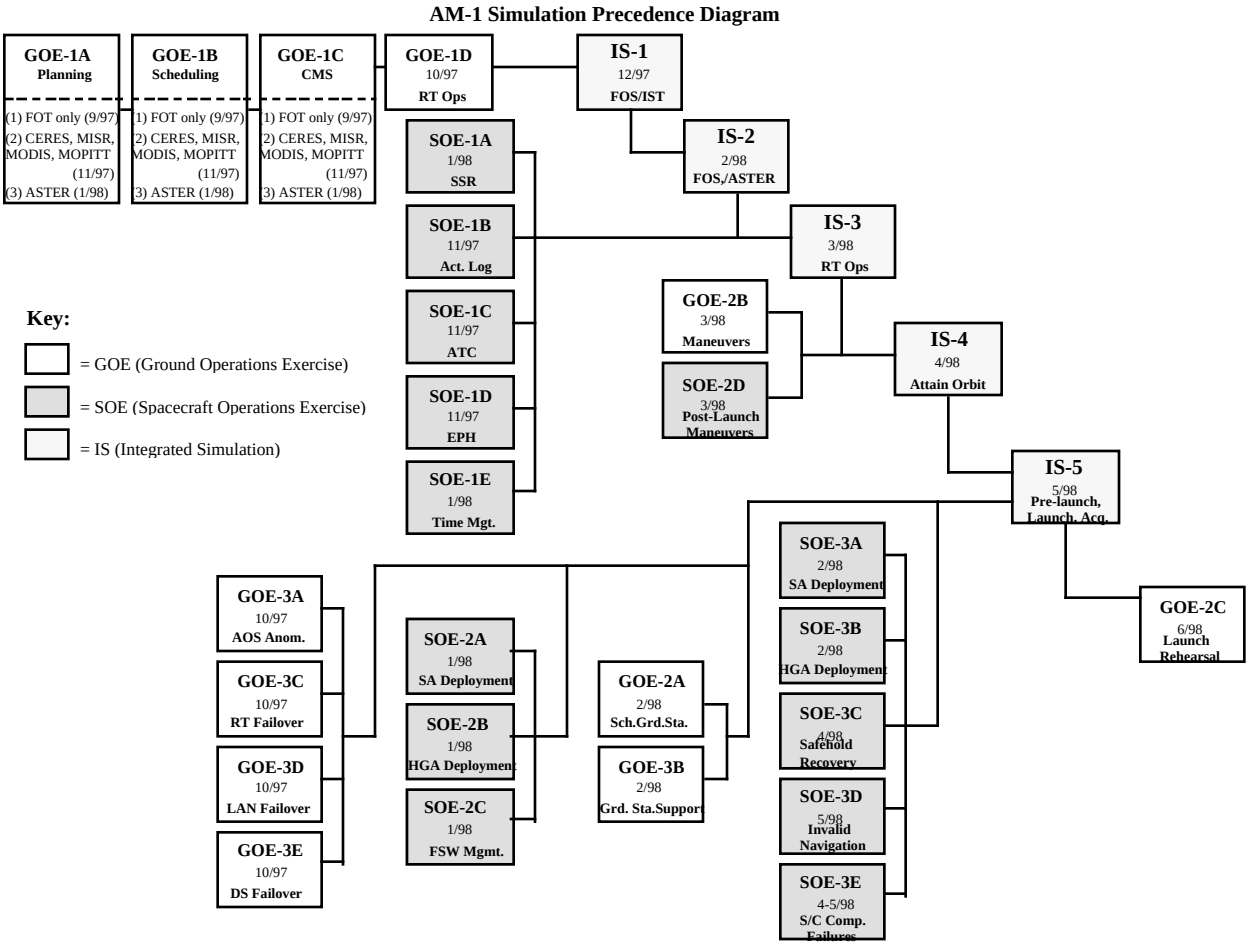


Figure 4.6-7. Integrated Simulations/Exercise Matrix

4.7 Training Exercises

This level of FOT training will be conducted using the spacecraft and ground operations exercises, the building blocks for the integrated simulations. The individual activities will be describes as follows:

4.7.1 SOE Normal Operations

Normal operations will include Solid State Recorder (SSR) management, dump of the activity log, the loading and dumping of the Absolute Time Command (ATC) and ephemeris, as well as exercising time correlation. These exercises are intended to train the FOT on how to accomplish day-to-day EOS operations.

SOE-1A SSR Management

This simulation will exercise the FOT's ability to manage the SSR. Nominally, the FOT will playback the entire SSR, both science and housekeeping data is contained in the buffers. The FOT will also playback subsets of the SSR. Full SSR buffers, missed data, and SSR replay will also be simulated.

SOE-1B Dump Activity Log

This simulation will allow the FOT to exercise activity log monitoring (H/K telemetry). The FOT will dump the activity log, and then interpret the results using the activity log browser. The FOT will also exercise the ability to manage and archive the activity log-related files within the FOS software.

SOE-1C Load/CRC and Dump/Compare ATC

This simulation will exercise the FOT load/CRC and dump/compare process. The FOT will uplink an ATC load, verify Cyclic Redundancy Check (CRC) check results, dump the ATC, and perform the dump image comparison. This simulation will also include a late change situation, and a situation whereas the onboard load has expired (to observe safing command execution).

SOE-1D Load/CRC and Dump/Compare EPH

This simulation will first exercise the FOT/FDD load generation process. The FOT will then uplink the load, verify CRC check results, dump the table, and perform the dump image comparison. The FOT will also perform the telemetry verification with both valid and invalid values.

SOE-1E Time Correlation Management

This simulation will exercise the FOT's ability to manage time correlation using spacecraft time set and Master Oscillator (MO) adjustment commands. The Return Data Delay (RDD) and User Spacecraft Clock Calibration System (USCCS) methods will be utilized. The automatic command request generation (MO/TONS) and a TDRSS On-board Navigation System (TONS) drift rate table update will be simulated.

4.7.2 SOE Special Operations

SOE special operations will include: solar array and High Gain Antenna (HGA) deployment, flight software patches and post-launch maneuvers.

SOE-2A Solar Array Deployment - Nominal Case

This simulation will allow the FOT to observe a nominal solar array deployment. Telemetry will be monitored to evaluate the success of the deployment. The FOT will then simulate the solar array rotation and the attainment of energy balance.

SOE-2B HGA Deployment - Nominal Case

This simulation will exercise the FOT's HGA deployment procedure in a nominal situation. Telemetry will be monitored to evaluate the success of the deployment. The FOT will then simulate the HGA rotation (gimbal checkout) and the attainment of energy balance.

SOE-2C FSW Management

This simulation will exercise the FSW patch process. The Software Development and Validation Facility (SDVF) will create a FSW maintenance load (patch). After it has been tested at the SDVF, it will be transmitted to CMS within the FOS software. The patch will then be tested by sending it to SSIM. A load and dump of the SCC and instrument microprocessors will be simulated also.

SOE-2D Post-Launch Maneuvers

This simulation will exercise the FDD/FOT post-launch maneuver process. The loads will be generated and several maneuvers will be scheduled and executed. Both attitude and propulsion maneuvers will be performed.

4.7.3 SOE Contingency Operations

SOE contingency operations will include: solar array and HGA failures, safehold recovery and invalid navigation practices.

SOE-3A Solar Array Deployment - Anomalous Case

This simulation will exercise a contingency solar array deployment. Failure conditions will be monitored in telemetry and contingency procedures will be executed in response to the failures. A simulated spacecraft control computer (SCC) halt will be simulated so that a ground deployment procedure can be exercised.

SOE-3B HGA Deployment - Anomalous Case

This simulation will exercise a contingency HGA deployment. Failure conditions will be monitored in telemetry and contingency procedures will be executed in response to the failures.

SOE-3C Safehold Recovery

This simulation will exercise the FOT's ability to recover from an earth-pointing safehold mode back to normal mode. The FOT will execute standard recovery procedures for the spacecraft bus and the instruments.

SOE-3D Invalid Navigation

This simulation will exercise the FOT's ability to recognize and recover from navigation errors. The errors will include both anomalous and absent measurement updates.

SOE-3E Spacecraft Component Failures

This simulation will exercise a variety of spacecraft subsystem component failures. The list of failures to simulate will be determined by the simulation team. Some examples of possible failures are the following: RWA, ESA, CTIU, thruster (stuck open/stuck closed), transponder, battery cell, and heater (stuck on/stuck off).

4.7.4 GOE Normal Operations

GOE normal operations exercises will include the planning and scheduling of operations, as well as exercising the CMS and uplinking real-time operations loads. The FOT will use PAS and CMS software tools for the generation of the ATC loads for the AM-1 spacecraft.

GOE-1A Planning

This simulation will utilize FDD planning aids, such as interference and visibility predictions, viewing times, predicted orbital events, etc. The FOT will access the FDD planning aids and verify their quality.

GOE-1B Scheduling

This simulation will exercise the FOT/IOT ability to schedule activities, Baseline Activity Profiles (BAPs), etc. for a nominal day. This exercise will account for the following: TDRS scheduling, Short Term Schedules (STSs) and One Day Schedules (ODSs) from ASTER, BAP installation, activity scheduling, constraints, late changes to the schedule, etc.

GOE-1C Command Management

This simulation will exercise the FOT's ability to generate loads (ATC, RTCS, and table) and the associated reports for the loads. A ground script will be generated as well.

GOE-1D Normal Real-Time Ops

This simulation will include executing a ground script. This simulation will also include the activities discussed in SOE Normal Operations.

4.7.5 GOE Special Operations

GOE special operations will include scheduling ground stations, maneuvers and launch rehearsal exercises.

GOE-2A Schedule Ground Station

This simulation will exercise the FOT's ability to schedule a ground station support in the case of TDRSS unavailability.

GOE-2B Maneuvers

This simulation will exercise the FDD/FOT/IOT process for Attitude Determination and Control (ADAC) maneuvers (attitude bias, attitude slew, and pitch). The maneuvers will be scheduled and executed.

GOE-2C Launch Rehearsal

This simulation will exercise the IS-5 Pre-launch, Launch, and Acquisition scenario as often as necessary before launch. This simulation will be a rehearsal for a nominal launch, but may contain occasional small anomalies. It is expected that this simulation will be exercised numerous times.

4.7.6 GOE Contingency Operations

GOE contingency operations will include: AOS anomalies, ground station supports and failovers with the RT server, LAN and DS.

GOE-3A AOS Blind, Late, Negative

This simulation will exercise the FOT's ability to react to blind, late, and negative AOS. The FOT will utilize standard procedures to diagnose and resolve these anomalies.

GOE-3B Ground Station Support

This simulation will exercise the FOT's ability to support a ground station contact in the event that TDRSS is unavailable.

GOE-3C RT Server Failover

The FOT will simulate a FOS Real-Time Server (RTS) failover. The failure recovery is an automated, not automatic, function so the FOT will initiate the failover. Complete recovery to a backup RTS will be demonstrated.

GOE-3D LAN Failover

The FOT will simulate a FOS Local Area Network (LAN) failover. The EOC network consists of two LANs: Operational and Support. The Operational LAN will be used for real-time operations. The Support LAN will be used by the FOS Sustaining Engineers to code and test FOS enhancements. The FOT will simulate failover of real-time operation activities from the

Operational LAN to the Support LAN. Devices will be attached to both LANs, allowing devices to switch functions without reconfiguring hardware.

GOE-3E DS Failover

The FOT will simulate a FOS Data Server (DS) failover. The failure recovery is an automated, not automatic, function so the FOT will initiate the failover. Complete recovery to a backup DS will be demonstrated.

4.7.7 FOT Integrated Simulations

The FOT will be involved with 4 to 5 full scale ISs that are built from the GOEs and SOEs training exercises. The ISs will practice the procedural implementation of all control center entities and exercise the coordination between these facilities. The configuration of the integrated simulations is displayed in Figure 6.

IS-1 FOS-IST Interactions, Normal Operations

This simulation will focus on FOS-IST planning and scheduling, as well as exercising products for uplink command loads and tables for use by SSIM.

IS-2 FOS-ASTER ICC Interaction, Normal Operations

This simulation will focus on FOS-ASTER planning and scheduling, as well as exercising products for uplink command loads and tables for use by SSIM.

IS-3 Normal Real-Time Operations

This integrated simulation will include SSR management, dump of the activity log, the load of the ATC and ephemeris, as well as exercising time correlation. For more details, reference Spacecraft Operations Exercises SOE-1A through SOE-1E above.

IS-4 Attain Mission Orbit

The orbit adjust mission phase is to boost the spacecraft to its operational science taking orbit after the initial orbit insertion by the launch vehicle. The orbit adjust simulation will exercise orbit adjust procedures, trim maneuvers and Go/No-Go decisions for maneuvers.

IS-5 Pre-launch/Launch/Acquisition

Pre-launch simulations are launch configuration preparation and Go-for-launch activities that focus on spacecraft and instrument configuration prior to lift-off. The main objective for the launch simulation is to stress system operations interfaces for problem solving between personnel at all levels from the launch mission management team to the operations, and stress the physical resources supporting the EOS mission.

The FOT will practice voice link confirmations, SCC/CTIU dumps, rate nulling and earth acquisition. Day/night transition and AOS/LOS will be simulated, FDF range data will be provided and the deployment of the solar array and HGA via ground command will be practiced.

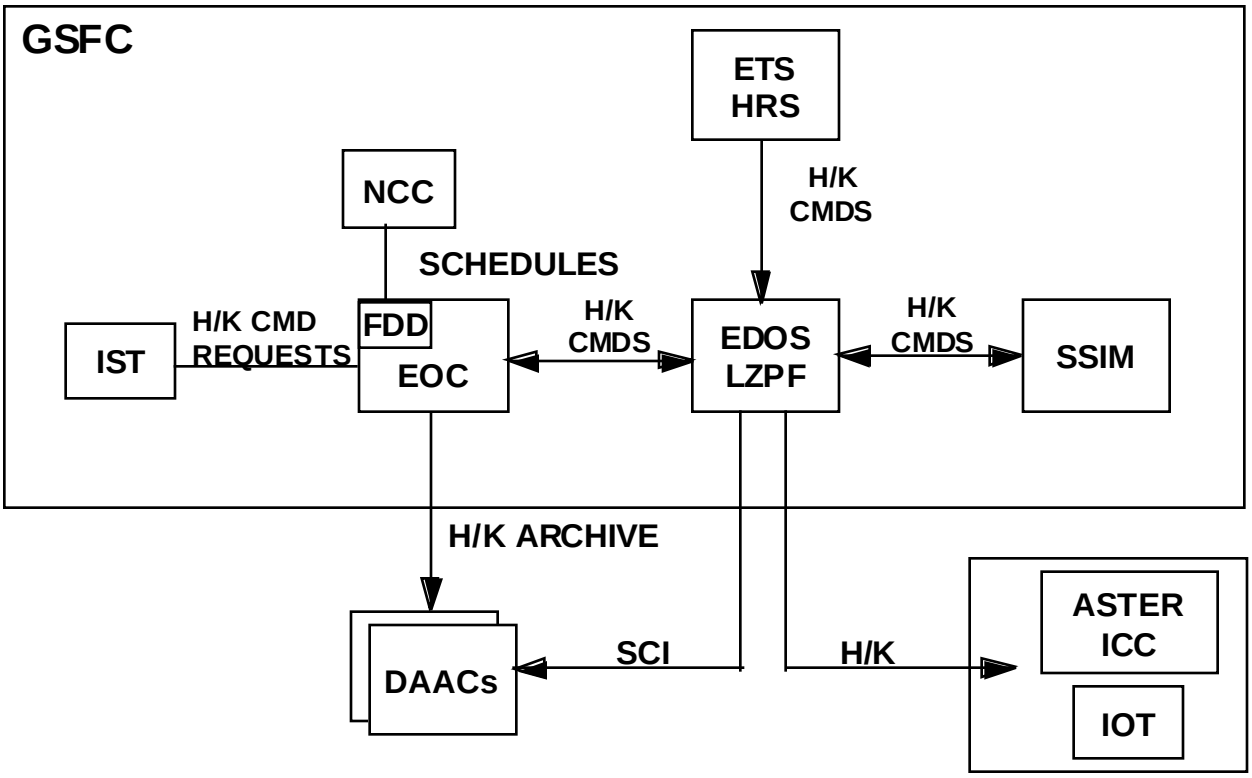


Figure 4.7.7-1. Configuration of Integrated Simulations

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Appendix A. Day in the Life of AM-1 Normal Operations

Overview

Items to be covered are for Nominal Daily Operation

FOT team work is represented through the activities of:

- Scheduling
- Analysis
- Off line
- Real-time
- Real-time Operations
- Monitoring health and safety telemetry
- Monitoring instrument telemetry
- Uplinking Loads
- Dumping the SSR
- Dumping Activity Log
- Real-time commanding
- Scheduling

Long range science plans from IOTs are submitted to Plans and Scheduling

TDRSS scheduling is handled through the PAS with the Comm Contact Scheduler

FDF inputs are submitted to the FOT to determine AM1 view periods for scheduling contacts

Scheduling is handled in three periods: Prescheduling, Forecast, and Active

Prescheduling is one week prior to the Forecast period and is when the TDRSS Scheduling request are submitted to NCC

Forecast is 2 weeks prior to the week being covered and is totally under the control of NCC scheduling

Active is the period from the end of the Forecast period and current time. This is when additions and deletions are made by the schedulers (This period can range from 1 to 2 weeks)

Contacts

Duration of contacts

Contacts will be 12 minutes in length with two contacts per orbit

Number per Day

24 K-band returns for SSR playbacks

24 S-band forward and return for commanding, loads, and real time telemetry monitoring

One S-band event will be non-coherent to directly measure master oscillator frequency

NOTE: The S-band events will coincide with the K-band events

Loads

Types of Loads

ATC

Interleaved combination of spacecraft and instrument commands

Spacecraft command storage capacity - 3000 commands

TDRSS

4 element loads(1 for each TDRS)

4 state loads (1 for each TDRS) and 1 model load

AM-1 Elements

1 element load

Instrument Microprocessor

IOT will supply the loads to the FOT for upload

FOT and IOT will coordinate prior to real-time contact (must be in EOC @AOS-20 minutes)

During upload FOT and IOT will monitor to ensure a successful uplink

UT1 > correct UT1 time to UTC time

SSR Playbacks

SSR management is initiated via FOS SSR management tool

Average playback is 6 minutes (full requires 17 minutes)

Five SSR buffers

Low-rate science

CERES

MOPITT

Housekeeping

Ancillary data

MISR

MODIS

ASTER

Trash

Analysis

Real-Time

Clock Correlation- evaluates the bias (clock error) between the UTC and the onboard spacecraft clock. The clock error will be controlled by adjustments to the Master Oscillator Frequency.

SSR Manager - assist the online controllers during playback and replays of the SSR buffers. The SSR manager will display the status of the buffers during the contact.

DSS- Real-time monitoring of telemetry and ground support

Off-Line

Analysis Request

2 - 12 hour continuous plots

Orbitial Plots

Request by the off-line subsystem engineers on an as needed basis

Instruments

ASTER- Advanced Spacebourne Thermal Emission and Reflection Radiometer (Japan)

CERES- Clouds and the Earth's Radiant Energy System (Langley)

MISR- Multiangle Imaging Spectroradiometer (JPL)

MODIS- Moderate-Resolution Imaging Spectroradiometer (Goddard)

MOPITT- Measurements of Pollution in the Troposphere (Canada)

On Line Shift Staffing

Operations Controller/Shift Supervisor

Lead FOT on-shift position, performs shift briefings and debriefings

Monitors FOS activity timelines, TDRSS performance data, and spacecraft clock drifts and approves FOT real-time command uplinks

Command Activity Controller

Controls and verifies FOS ground script execution, transmits and verifies commands and load uplinks

Monitors TDRSS performance data, voice and datalines, EDOS configuration and status messages, and transmits required TDRSS reconfiguration request

Spacecraft Engineer / Instrument Evaluator (2)

Monitors spacecraft subsystem and instrument health, safety, and ground script execution (instrument health and safety will be monitored by the instrument evaluator the primary telemetry points identified by the IOTs)

Reviews, monitors, and supports command activity, spacecraft activity log, spacecraft recorder management, and clock maintenance

For more information

Flight Operations Segment Operations Tool Manual for the ECS Project

EOS AM-1 Mission Operations Review (Nov 20-12,1997)

FOT Training Handouts

Appendix B. Project Database

Overview

The PDB is used for mission planning, commanding, and telemetry processing.

The PDB resides in the FOS Database, which utilizes a Sybase RDBMS.

The PDB is a CI, meaning that it is configuration controlled by the Operations CCB.

Vocabulary

PDB - Project Database: The PDB consists of telemetry, command, activity, and constraint definitions from the Spacecraft Contractor I&T database, the FOT, and the IOTs.

Once the PDB is loaded into the FOS database, it is located in the Unvalidated Database, in Sybase tables.

Once the PDB is validated, it is located in the Validated Database, in Sybase tables.

Once validation is complete, operational data is generated in 2 forms:

ODB - Operational Database: The database tables that FOS offline software applications use to access operational data.

ODF - Operational Data Files: The UNIX files that FOS real-time software applications use to access operational data.

PDB Structure

The PDB consists of telemetry, command, activity, and constraint definitions from the Spacecraft Contractor I&T database, the FOT, and the IOTs.

Initially, the basic telemetry and command PDB is derived from the I&T database. The FOT and IOTs then provide activity and constraint definitions, and any additional information or updates to support telemetry and command processing. (i.e., derived parameters, changes to red/yellow limits, prerequisite state checks for commands, etc.)

PDB files provided by the S/C contractor are in ASCII format. The specific structure for each of these ASCII files is outlined in the DFCD for the EOS FOS PDB, Vol. 2, AM-1 Mission.

PDB information is provided by the FOT and IOTs using the database edit tool, the Activity Definer Tool, and the Constraint Definer Tool.

PDB Definitions

The DFCD for the EOS FOS PDB, Vol. 1, Generic, describes each PDB definition in detail.

The following tables list each of the definitions:

Telemetry

Command

Activity

Constraint

PDB Access

The telemetry, command, and command constraint PDB files may be viewed using WWW pages.

Currently, anyone may bring up the

http://www.eoc.ecs.nasa.gov/db_util/db_util_usr.html page to browse the UNVALIDATED database.

The format of the WWW pages is being changed with the December release of FOS software. The new WWW pages will be password protected for browsing and for submitting database edits. Detailed information for use of the new WWW pages will be provided with the FOS December release.

PDB Processing

New versions of the PDB may be created in the following ways:

Complete new version, updating telemetry, command, activity, and constraint information

New version of activity information only

New version of constraint information only

Versions are numbered in the following manner:

N1.N2.N3, where

N1 corresponds to telemetry and command definitions

N2 corresponds to constraint definitions

N3 corresponds to activity definitions

For example,

1.1.1 Original version of the database

2.1.1 New version of the database

2.2.1 New version of constraints only

2.2.2 New version of constraints and activities

PDB Processing

Steps for processing a new version of the PDB:

1. Receive a new version of the PDB from the S/C contractor
2. PDB files are loaded into the Unvalidated PDB by the FOT DBA
3. FOT/IOTs make edits to the test database
4. FOT/IOTs submit CCR to Operations CCB for review
5. Approved CCRs are loaded into the Unvalidated PDB by the FOT DBA
6. FOT DBA performs PDB validation
7. FOT DBA performs ODB/ODF generation
8. PDB Reports are generated
9. FOT tests new PDB
10. FOT uses new PDB operationally
11. Distribute new release of PDB to ISTs, ICC, GSFC PML, ETS, SSIM, etc.
12. IOTs test new PDB
13. IOTs submit validation forms for CCRs

PDB Processing

1. Receive a new version of the PDB from the S/C contractor Telemetry and command files in ASCII format according to DFCD
2. PDB files are loaded into the Unvalidated PDB by the FOT DBA using a script or WWW DBA page
3. FOT/IOTs make edits to the test database

To edit telemetry, command, or command constraint information:

FOT/IOTs will have access to a WWW page that will allow users to add, update, or remove telemetry, command, and command constraint information.

The page will be password protected in 2 ways: there will be a password for browsing database information, and there will be another password for submitting additions, updates, or deletions.

The edits will be entered into a test database on the Support LAN at the EOC.

To edit activity or activity constraint information

FOT/IOTs will use the activity definer and the constraint definer to make changes. Details for these processes are provided in the Activity Definition Training.

4. FOT/IOTs submit CCR to Operations CCB for review

Follow guidelines outlined in the FOT Configuration Management SOP

5. Information from approved CCRs is loaded into the Unvalidated PDB by the FOT DBA

Using a script, the FOT DBA marks the test database entry from the CCR as CCB-approved. Then the entry is loaded into the unvalidated database on the Support LAN.

6. FOT DBA performs PDB validation

PDB validation includes syntax checking, verification of values, and cross-checking of related definition files

As a result of this stage of PDB processing, data is loaded into the validated database on the Support LAN.

7. FOT DBA performs ODB/ODF generation

The validated data is copied into the operational database on the Support LAN for FOS offline software applications to access.

Operational database files are created for FOS real-time software applications to access.

8. PDB Reports are generated

4 reports are generated:

tlm_pdb_rpt - a report containing information for each telemetry mnemonic that passed validation

tlm_valog_rpt - a report containing error messages for each telemetry mnemonic that failed validation

cmd_pdb_rpt - a report containing information for each command mnemonic that passed validation

cmd_valog_rpt - a report containing error messages for each command mnemonic that failed validation

Reports are made available for ftp on an EOC M&O machine

9. FOT tests new PDB

FOT uses new PDB on Support LAN in parallel with old PDB on Operational LAN until satisfied with results

10. FOT uses new PDB operationally

FOT DBA repeats PDB validation, ODB/ODF generation for new PDB on Operational LAN

11. Distribute new release of PDB to ISTs, ICC, GSFC PML, ETS, SSIM, etc.

ICC, GSFC PML, ETS, and SSIM receive validated PDB files in ASCII format

ISTs receive ODF files for FOS software applications

12. IOTs test new PDB

Verify CCRs were implemented and verify changes have the desired results

13. IOTs submit validation forms for CCRs

Follow guidelines outlined in the FOT Configuration Management SOP

Summary

PDB is a configured item, change requests must go through Operations CCB

When changes are approved and/or new I&T database files are available from the S/C contractor, the FOT DBA loads new information/edits into unvalidated database on Support LAN

FOT DBA performs validation and generation of operational data

Reports are generated

Database is checked out and then used operationally

Database is distributed

IOTs test CCRs and submit validation forms to CCB

References

For further information, refer to the following:

505-10-35-1 and 505-10-35-2: Data Format Control Document (DFCD) for Earth Observing System (EOS) Flight Operations Segment (FOS) Project Data Base, Volumes 1 and 2

102-CD-002-001: Flight Operations Segment (FOS) Operations Tools Manual for the ECS Project

FOT Project Database SOP

FOT Configuration Management SOP

Activity Definitions training session

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Appendix C. ECS Command Language

Overview

The ECS Command Language is the language for all EOC real-time Command and Control operations.

ECL is a simple procedural language consisting of the following constructs:

a basis character set: A-Z, a-z, 0-9, &, (,), *, +, -, /, !, \, ~, % ,< ,> ,=, ^, |, _, $, #, :, @

Literals:

integer	12345
real	3.1415
hex, octal, binary	0x32FB, 8x712, 2x010101
time value	20:30:00
date value	1998/168
degree value	92.5 DEG
character	“x”

ECL is case sensitive.

Arithmetic Operators - operator set from the “C” programming language.

Comment Delimiter: “#”

Continuation: “\”

Directives:

Spacecraft

Bus and Instrument Command mnemonics

Defined in the FOS PDB.

Executed by prefixing a “/” character

Ground

FOS System commands

Defined in Appendix A, ECS Command Language, of the FOS Ops. Tools Manual

Executed without prefixing a “/” character

Built-in Math Functions:

ACOS	Arc Cosine
ASIN	Arc Sine
COS	Cosine
Sin	Sine
TAN	Tangent
COSH	Hyperbolic Cosine
SINH	Hyperbolic Sin
TANH	Hyperbolic Tangent
EXP	Exponential
LOG	Natural Logarithm
LOG10	Base-10 Logarithm
POW	Power
SQRT	Square Root
FABS	Absolute value

Telemetry Parameter Mnemonics

allows the use of telemetry values as parameters within a procedure.

Format:

[F | D | R]@mnemonic

where:

F = Formatted - Engineering Unit or Discrete Text Conversion.

D = Decoded - 1750A floating Point Format.

R = Raw - Unconverted telemetry value.

Conditional Constructs:

If … else if …

Switch … Case

if(conditional expression)

{ (Braces are required)

}

else if(conditional expression)

{ (Braces are required)

}

Conditional Constructs cont.

switch(integer expression)

{case n:

<*ECL statement*>

Break

case n +m:

<*ECL statement*>

Break

default:

<*ECL statement*>

Break

}

Loop Constructs

while(conditional expression) - pre-test

{

<directives>

}

do - post-test

{

<directives>

} until (conditional expression)

for(initial expression; terminal expression; loop expression) -iterative

{

<directives>

}

ECL Procedures

The ECS Command Language is the language for all EOC real-time Command and Control operations.

ECL Procedures: collections of functionally and logically related spacecraft and ground directives, designed to affect a unique result.

turn on or off subsystem components

uplink loads

set gain values

execute a calibration sequence

ECL Procedures are Configured Items(CI), under the control of the FOT CCB.

Procedure Architecture

All ECL procedures shall be based on the following template:

Procedure Prototype Statement

Procedure Function Message

Header

Local Variables

Global Variables

Hard WAIT GO or Kill Statement

Body

Procedure Termination Message

END PROC Terminating Statement

Procedure Prototype Statement

ECL requires that all procedures begin with a prototype statement of the following format:

PROC ProcedureName([optional list of arguments])

where:

PROC is required.

ProcedureName is required and limited to 32 characters.

() is required

Procedure Functionality Message

Procedure Functionality Message

a message block with the procedure's functional purpose.

Example:

MSG "MODIS Microprocessor Load Uplink Procedure"

or

MSG "ASTER Select MPA and Turn Survival Heater Enable"

Procedure Header Format

The procedure header is used to document specific information about the procedure and is used by the FOT for maintenance and execution of that procedure.

The header is required for all procedures.

The header includes the following:

an identifier section that consists of:

affiliation / Project / Company

Author

Date Created

Revisions (must include date and purpose of revision)

Satellite ID - AM-1

Category (Subsystem and major component)

Sign Off:

FOT: Authorized FOT Member

FOD: NASA FOD

IOT: Authorized IOT Member

Procedure Header Format

Header Format Cont.

PROCs Required: List of ECL Procedures called by this procedure.

Loads Required: List of Loads Uplinked by this procedure.

Arguments: A list of the passed in arguments and their purpose.

Display pages required: List of Display pages needed for telemetry verification, and a sub list of the commands associated with each page.

Variables and Scope

ECL provides for Local Variables and Global Variables.

Local variables are visible only within the procedure that declares them.

Local variable names must begin with a single "$" character.

Local Variable names can contain up to 32 characters, including any combination of letters(Upper and Lower Case), digits, and underscores.

Compound variable names should be delimited with the underscore, similar to the mnemonic format.

Global variables are visible to the procedure that defines them and all procedures that are called by that procedure.

Global variable names must begin with a double"$$" character.

Hard Wait, Go or Kill

Hard WAIT GO or Kill Statement

Each procedure shall follow the variable declaration sections with the following ECL statement:

WAIT #HIT 'GO' TO CONTINUE OR 'KILL' TO TERMINATE THE PROCEDURE.

The Operators shall query all real-time participants for status and a GO or NO-GO call at this point in the procedure.

Operators will skip to a specific procedure label/section from this statement, if the procedure has been "continued" from the previous real-time contact.

Procedure Body

Command Records

The FOT will enforce documentation of ECL procedures to be executed within the EOC.

The following "Command record" format should be used for all command directives:

/MNEMONIC [OPTIONAL SUBFIELDS] #PDB short description.

(Command Description Record)

Example:

/AST_TURN_ON_CSPA #ASTER CSP-A ON

or

/AST_SELECT_MPSA #MPS A SELECT

Procedure Body Logic

Pre-requisite State Checks

Logical constructs used to verify that the target subsystem state is consistent with the intended commanding.

Formulate Pre-requisite State Check Logic:

For each sequence of commands, determine the subsystem state either required for the commanding or that would conflict with the commanding,

Determine what actions to take if the desired state is not found: stop the procedure, or command the correct state.

Compose compound logic blocks to test for the state.

Include messages and or prompts within your logic as instructions to the FOT as to how to proceed.

Procedure Body Logic

Controlling Flow with Waits, Prompts, and Loops

Use the WAIT Directive formats to control the sequential execution of a procedure:

relative timed WAIT, to allow time to evaluate the result of a command

```
WAIT 10              #wait 10 seconds for tlm update
```

Hard WAIT, pause procedure execution until desired telemetry states are achieved, or approval to continue is given

```
WAIT          #Verify NAV State NOW
```

Telemetry WAIT, pause execution until a desired telemetry point reflects a required state.

```
WAIT (F@AST_BR_C_A_ON_OFF ==‘ON’)
```

Recommended form, but may lengthen procedure execution time.

Procedure Body Logic

Controlling Flow with Waits, Prompts, and Loops

The PROMPT directive should be used to establish a dialogue.

The dialogue may represent a choice as to how to proceed, or

The operator is requested for an input of a value required to continue.

This dialogue act to improve the procedure-operator interaction.

And, allows for creation of a generic, re-useable procedure

Procedure Body Logic

Controlling Flow with Waits, Prompts, and Loops

Loops are to be used for execution of a repetition of command directives.

The most common occurrence is the loading of a multi-partition microprocessor load.

Loops may be used to encapsulate a group of commands that are to be re-executed if a desired telemetry state was not achieved.

Procedure Logic

Command Execution Verification(CEV) Logic

All commanding should be verified.

Logic should be included to test the state of telemetry to verify the attainment of the intended state.

Choices for testing are:

the Telemetry WAIT directive

a complex if … then block

a derived telemetry parameter/variable within a post test loop expression(do … until(expression))

a message to the operator as to the results of the CEV logic and instructions on how to continue.

Re-entrant Procedures

Real-time commanding is often subject to interrupts.

Lengthy procedures may not be completed during a single contact.

Procedures with long relative WAIT directives may not be completed within a single contact.

These procedure need to be written so they can be re-started.

The operator can pick up where he left off.

Re-entrant features:

> Labels should be used to functionally group commands
>
> Comments should be used to advise the operator where he could stop the procedure and restart later.
>
> The operator may then restart a procedure, skip to the label, and resume commanding.
>
> Caution: Loops should be considered atomic. An operator should never restart a procedure within a loop.

Summary

The FOT desires:

Well documented, robust, procedures, that execute without failure or side affects,

are instructional to the operators, and are re-useable over the mission life

The constructs presented should aid the writing of most procedures required for the AM-1 mission.

For more information

Flight Operations Segment Operations Tool Manual for the ECS Project.

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Appendix D. Display Page Generation

Overview

3 main Display Components

Display Page Contents

FIELD *Mnemonics*

LABEL *Desired Text*

SEPARATOR *Horiz or Vert*

Bringing Up the Display Builder

Bring up your UserStation

source UserStationStartup.nopas

DataServer must be up first

Click TOOLS from the Control Window at the bottom of your screen

Select Display Builder and click OK

The 5 Parts of the Display Builder:

1. Display_Builder Palette
2. Display Item Format
3. Display Item Data Sources
4. Display Builder Console
5. Display_Builder

Editing an Existing Page

In the Display_BuilderPalette:

File/Open

This results in a window named “Open”

Specify the Resident Directory for the Page to be Edited

Local = /home/*username*/pages/.

System =/fosb/test/AM1/displaydefs/

Make changes as desired

Save the Page With the New Edits

File/Save in the Display_BuilderPalette

Build to Local and CM (to be covered later)

Starting a New Page

In the Display_BuilderPalette:

Page/Logical String Management

This results in a window named

"Dynamic Page Logical String Management"

*Spacecraft: AM1

*Source: Real Time

*Mode: Operational

Then click Add and AM1 Real Time Operational Default

will be displayed

Click OK

Adding Page Content

In the Display Item Data Sources:

Add and Remove are now interactive

In the Display Item Parameter Selector :

Click Filter to view the Selection Filter page

Spacecraft

Instrument (Subsystem)

Sample Type (Alphabetical Designation)

Click OK

The Display Item Parameter Selector Now Shows Your Selection

Click the Radio Button to Populate the Available Parameter

Portion of the Parameter Selector

Once Mnemonics Are Placed Under Selected Parameters,

They Can Be Positioned Onto the Display Page

A Blank Field Must First Be Positioned Onto the Display

By Clicking OK, the Mnemonic Displayed In the Selected

Parameter Column Will Be Placed Into the Empty Field

Repeat the Process For Each Desired Mnemonic

Selected Parameters Column must be cleared before

choosing more mnemonics

To Select Mnemonics From a Different Instrument (Subsystem)

Deselect Radio Button and Allow the Available

Parameters Column to Clear

Hit Filter and Re-specify Desired Instrument

Add Mnemonics As Previously Outlined

Saving and Building

After you have completed your page, there are two things that must be

done before you terminate the session:

1.) You must save your work

File/Save As…

Click System (/fosb/test/AM1/displaydefs/)

Assign name at end of directory path

When assigning names, the following naming convention should be adhered to in order to avoid any conflicts.

Pages	_DISP
Tables	_TBL
Graphs	_GRPH
Mixtures	_MIX

2.) After the page is saved, it must be Built to:

Local - Your Home directory

CM - /fosb/test/AM1/displaydefs/*pagename*

You can build to local to make the page immediately accessible

in your Home directory

To have your page built to CM, You must first submit a copy of your

page along with a CCR to the CCB for approval. Once the CCB

approves your page, it will be built to CM so that all users can access it.

Tables and Graphs

The Display Builder also has the capability to create both

Tables and Graphs

Tables display mnemonic values in a spreadsheet type display

The Graph displays mnemonic values in a traditional X-Y Axis format

Tables and Graphs are created, saved and built to Local and CM in much the same manner as the Display Pages

Summary

The Display Builder is a tool used to create Display Pages, Graphs and Tables in order to monitor telemetry

Pages can also be edited by using the Display Builder

The User Station must be up in order to use the Display Builder

To name a page, table, or graph, a naming convention must

be used. (_DISP, _TBL, _GRPH, _MIX)

You can build a page to Local, but the CCB must be used to get a page built to CM

Where to get more information

FOS Operations Tools Manual

FOT Standard Operating Procedures

FOS Software Developers

FOT Members

Appendix E. Activity Definer

Overview

First step in the Planning and Scheduling process

Allows FOT and IOT's to group commands together which will be used to operate subsystem components onboard the spacecraft

Users define Activities for individual Resources pertaining to their subsystem component

Provides users with the capability of performing one or more commanding functions

Allows users to include ATC commands, Ground commands, ECL directives and procedures, Mode changes, and other Activities

Configuration Controlled item

Purpose

Group together a series of commands, modes, ECL Directives, Procedures, and Scheduling Information associated with individual Resources

Associate offset times relative to the start or stop of an Activity

Combine both ATC and Ground Commands (optional)

Maintain control of what is uplinked to the Spacecraft

Usage

Create Activities for Spacecraft Bus components

Create Activities for Instrument components

Timeline Scheduling

Building Blocks for BAP's

Building Blocks Detailed Activity Schedule (DAS) and Absolute Time Command Table load (ATC)

Options and Functions

Activity Level Constraints

Constraint Definer Tool

A rule indicating when a scheduled Activity or Mode should or should not occur during a certain event (Maneuver) or another Activity or Mode

Prevent personnel from scheduling Activities which could possibly affect the health and safety of the spacecraft or instrument(s)

Hard or Soft Constraints are defined based on spacecraft and instrument requirements/ restrictions

Soft Constraints can be overridden with approval

Hard Constraints will not allow generation of an ATC load until it is resolved

Used during CCB Validation process

Activity CCB Process

Validation and Test of an Activity prior to incorporation into PDB

Vocabulary

Activity - Sequence of commands used to operate spacecraft components

Activity Component - A single item that can be used within an Activity

Command - A defined instruction or action to be carried out by a spacecraft and instrument payload

Command Parameter - A value associated with commands defined within the database

Complex Activity - An Activity containing one or more Activity Definitions

ECL Directive - Keyword recognized by ECL command language parser and used in ECL command procedures

Default Scheduling Info - Default start/stop time or event commonly associated with an Activity

Relative Offset Time - Time at which command/mode will execute relative to the start time of the Activity

Timeline - Tool used to view and schedule Activities against Resources on board the spacecraft

Activity-Level Constraint - Rule restricting schedulability of an Activity

Summary

The Activity Definitions are the means by which commands are grouped together to command spacecraft and instrument components

Activity Definer Tool allows complex commanding functions

Method of controlling what is uplinked to the spacecraft and instrument subsystems

Activities are a Configuration Controlled item and must be validated and submitted for approval to the Configuration Control Board (CCB)

Hands-on training available via ECS IST

Feedback is encouraged (Questions)

Where to get more information

BAP Definer, Planning and Scheduling/CMS ECL Procedures, Project Database, Simulations presentation material

Flight Operations Team Standard Operating Procedures (White Paper)

FOS Operations Tool Manual for the ECS Project

Flight Ops Team members

FOS Software Developers

DID 605 and 609 Documents

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Appendix F. Event Messages and Browsing

Calling Up the Events Display

Ensure your User Station is up

Click the Tools button on the Control Window

Select the type of Event Display you would like:

Global - Shows all event messages that are generated for all users connected to the string

Local - Only shows event messages that are related to the functions that you are performing

The events can be resized and relocated according to your preferences

Event Display Features

Show Graph - Used to apply or remove the graph feature

Allows more text to be displayed in a smaller space

Lock Scroll - Inhibits the scrolling feature on the Events

Makes it much easier to read events

Search String: A selective filter used to search all event messages

Enter a key word or number

Depress the Search or Filter button

Search-Displays messages that contain key word

Filter-Filters out messages that don't contain key word

Hit Apply

Reset is used to restore the Events page to it's previous state

Another type of Events filter is contained on the pull down menu located at the top of the Events Page

Click the Filter button and select Events

Use the buttons to customize your Event Display

Select which type of messages to show

Select which type of messages to exclude

Display selected message types in bold type

Click Apply and Close

Types of Event Messages

> TLM	Telemetry	> ANL	Analysis
> CMD	Command	> PAS	Planning & Scheduling
> CMS	Command Mgt. Sys.	> SYS	System
> DMS	Data Mgt. Sys.	> RCM	R/T Contact Manager
> FUI	FOS User Interface	> RMS	R/T Management System

Snapping an Event Display

There are several ways to print the contents of the Events Display

Type "snapframe" in an X-term or a Command Tool and then click the cursor in the Events Display

This will print a copy of the Events Display to a printer

Snapshot is a tool that can also be used to snap the Events Display

Right click on the desktop of the Work Station

Select Programs and then Snapshot

A Snapshot box will then be displayed

Using the WWW to View Events

Invoke Netscape and enter the following address for the Location:

http://www.eoc.ecs.nasa.gov/evhistform.html

Once at this site, fill in the interactive boxes in order to specify the necessary information

>When these specifications are submitted, all applicable archived Event messages will be displayed

Summary

The Global Event Display reflects all messages while the Local Events Display only reflects events from your Work Station.

If desired, multiple Event Displays can be used to reflect different types of events.

By using the Internet, you can look up archived Event messages.

The contents of the Event Display can easily be printed to a printer.

You don't have to be connected to a logical string in order to use an Events Display.

Where to get more information

FOS Operations Tools Manual

FOT Standard Operating Procedures

FOS Software Developers

FOT Members

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Appendix G. Logical Strings

Logical Strings

A logical string can be defined as the hardware hosts and the associated software supporting a real-time, sim, or history replay for a S/C.

Logical Strings can be shared thus allowing the IST's the capability to access the same data streams as the EOC.

>monitoring of real-time contacts

>simulation of real-time contacts

>history replays

Logical Strings are identified by a number ranging from 1 to 999

Primary vs. Backup

The Primary Logical String is the main string used for the sending of Commands and the reception of telemetry.

In the event of a hardware or software failure of the Primary Logical String, a Backup String is used as a "Hot Backup" in order to ensure a method of timely and efficient recovery

>Backup Logical Strings are created manually by the FOT

>Consists of Redundant Processing on a separate Real-Time Server

String Creation

Logical Strings can be established manually or as a default

>Manually : on the ECL line of the Control Window

*STRING CREATE REALTIME SPACECRAFTID=AM1 MODE=OPERATIONAL SERVER=1

>As a Default, the String is created when the Real-Time Server Startup Script is executed.

*An Event message will indicate when the string has been successfully created

Connecting to a String

Once the String is Created, You May Connect to it

STRING CONNECT STRING=100 CONFIG=MIRROR

Event messages will inform you of status

A Mirrored connection uses the same configuration as the Ground Controller for the logical string

A Tailored connection allows you to customize the configuration of the local resources that you are using

Successful connection to a string is necessary in order to perform such functions as:

Take Ground Control and / or Command Authority *

Send Commands *

Monitor and Process Telemetry

Perform Simulations

*FOT Only

Disconnecting From a String

You may disconnect from the logical string by using the STRING DISCONNECT directive on the ECL line.

STRING DISCONNECT STRING=100

Event messages will inform you of the disconnect status

It's always a good idea to perform a STRING DISCONNECT before shutting down your User Station

Summary

The Real-Time Server is the piece of equipment that the Logical Strings are dependent upon

For each string created, a dedicated Real-Time Server is needed

Without a string to connect to, the FOT can't accomplish any type of real-time support, simulations, or history replays

IST's are dependent upon a successful string connection in much the same way as the EOC is

A "Hot Backup" will be used for nominal operations to ensure a timely "failover" in the event of a failure of the Primary String

Where to get more information

FOS Operations Tools Manual

FOT Standard Operating Procedures

FOS Software Developers, FOT Members

Appendix H. Microprocessor Load Methodology

Overview

Microprocessor loads and dumps are performed by the FOT.

These loads and dumps must be scheduled through ordinary methods.

The IOTs will either schedule mode transitions, or supply the FOT with Command procedures that will command their instrument to the proper state.

The load and command procedure must be received in the EOC 20 minutes prior to the scheduled contact for emergencies, or 2 days for a normal operation.

AM-1 Spacecraft Modes

Microprocessor Loads can be performed with the Spacecraft in the following modes: Safe mode (with the SCC running) and Science Mode.

Instrument Operation Teams will have to specify which mode their instrument shall be in to receive the load or perform the microprocessor dump.

Scheduling a Microprocessor Load / Dump

The IOT will schedule Microprocessor Loads and Dumps as they would schedule any other event.

The IOT can schedule the necessary instrument mode transitions either through Stored Commands or through an ECL command procedure that will be executed on the ground in real-time.

The ECL procedure should be built with pre-requisite state checking included.

The ECL procedure should disable any TMONs, or RTCSs that might command the instrument during this operation.

The FOT will assist the IOT in building the ECL procedure.

Building Microprocessor Loads

The IOT will ingest the Binary Load File using the FOS Binary Load builder.

Using the Binary Load Builder the IOTs will create the uplink load.

The IOT will place the load in the proper directory for the FOT to retrieve.

The FOT, in conjunction with the IOT, will build an ECL uplink procedure that will be used to uplink the load.

Real-time Microprocessor Load Operations

After AOS the FOT will verify that the spacecraft and instrument are in the proper state for the Load Operation.

If the Instrument is going to be commanded to the proper Load state through an ECL procedure, then it will not be in the proper Load state at AOS.

If the Instrument was commanded through Stored Commands into the proper state, and has not reached that state, the FOT will contact the IOT and notify them of the problem.

After the initial states have been verified, the ECL uplink procedure will be started.

After the Load is complete the CRC check will be verified

If the CRC check passes, then the load completed nominally and the loaded data can be used.

If the CRC fails, it is up to the IOT to decide whether or not they want to dump the loaded memory to see what was incorrectly loaded.

After the CRC is verified the FOT will put the instrument into the proper mode according to the uplink procedure.

The FOT will verify that the instrument is in the proper state and enable any TMONs, RTCSs, etc. that were disabled.

Real-Time Microprocessor Dump Operations

After AOS the FOT will verify that the spacecraft and instrument are in the proper state for the Dump Operation.

If the Instrument is going to be commanded to the proper Load state through an ECL procedure, then it will not be in the proper Dump state at AOS.

If the Instrument was commanded through Stored Commands into the proper state, and has not reached that state, the FOT will contact the IOT and notify them of the problem.

After the initial states have been verified, the ECL dump procedure will be started.

When the dump is complete the FOT will put the instrument back into its normal operating mode, according to the downlink procedure.

The FOT/FOS does not interpret Microprocessor dumps. The dump will be sent to the IOT for interpretation.

Summary

Microprocessor Loads and Dumps will have to be a coordinated effort between the FOT and IOTs

Microprocessor Loads and Dumps will be scheduled like any other event.

The Load or Dump will be commanded using an ECL procedure.

Any anomalous results will be reported to the IOT immediately.

Where to get more information

ECL Procedure SOP

EOS AM-1 Instrument Operations Workshop presentation

EOS AM-1 Flight Systems Manual

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Appendix I. Inhibit ID

Overview

Inhibit IDs are used to inhibit stored commands.

There are 256 Inhibit groups.

TMONs, RTCSs, and ATCs can all be assigned Inhibit IDs.

Inhibit IDs are Configured Items and must undergo the CCB process.

Inhibit ID Usage aboard AM-1

Inhibit IDs will be used to ensure that commands that may harm the Spacecraft are not executed in the Stored Commands.

Inhibit IDs will be used to Inhibit TMON groups that may send commands that are harmful to the Spacecraft.

This could happen in an anomaly situation, where the nominal stored commands could cause damage due to a hardware problem.

Inhibit ID Operation

Inhibit ID Functionality

Each ATC, RTCS, or TMON Group can be assigned an Inhibit ID.

More than one Stored Command or TMON Group can be assigned to an Inhibit ID.

An Inhibit ID of 0 indicates that an item cannot be inhibited.

Setting an Inhibit ID for Stored Command does not inhibit processing of that command, it only inhibits the commands from being sent.

Setting an Inhibit ID for a TMON Group does not inhibit execution of that group, it only inhibits the commands that are sent.

Inhibiting RTCSs

Each RTCS can be assigned an Inhibit ID.

Each command in an inhibited RTCS is Logged in the Activity Log as being inhibited.

Inhibiting TMON Groups

Each TMON Group can be assigned an Inhibit ID

If the TMON trips while the Inhibit ID is set, then the TMON group is posted in the Activity Log as having the command inhibited.

Inhibit ID Submission

Inhibit IDs will be submitted in memo form and will include the following information:

1. The reason for submitting this particular Inhibit ID Group.
2. An analysis of and special spacecraft conditions that are required to implement the Inhibit ID Group.
3. A Inhibit ID Association table that describes the interactions this Inhibit ID has with the ATC, RTCSs, and TMONs.
4. A date, or time span, that the RTCS will have to be operational.
5. An analysis of any changes that might need to be made in the ATC, RTCSs, or TMON Groups.

The CCB will be responsible for validating the submitted Inhibit ID groups.

Changing an Inhibit ID

To change an Inhibit ID group association, one must rebuild the associated TMON, RTCS, or ATC command.

Once the new loads are built they can be uplinked according to the proper procedure.

CCB Approval

The CCB must approve the Inhibit ID groups.

Inhibit ID Association Table

Inhibit ID Allocations

The following allocations for Inhibit ID's have been set aside:

	Inhibit ID
Uninhibited	0
ASTER	1-9
CERES	10-19
MISR	20-29
MODIS	30-39
MOPITT	40-49
SC BUS	230-255
Unallocated	50-229

Summary

Inhibit IDs are flexible.

Inhibit ID groups must be submitted to the CCB with the proper information.

Where to get more information

Inhibit ID SOP

EOS AM-1 Instrument Operations Workshop presentation

EOS AM-1 Flight Systems Manual

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Appendix J. Trouble Tickets

Overview

Trouble Tickets are the users (IOTs, IPGs) way of reporting problems to the EOC

When a user has a problem they submit a Trouble Ticket. Once the FOT has the Trouble Ticket it is their responsibility to evaluate and assign it. (FOT will write any DRs if appropriate, and close the Trouble Ticket with the DR# assigned).

The current method for submitting a Trouble Ticket is to send e-mail to the FOT. In the future a COTS package called Remedy will be used. Trouble Tickets will be submitted via a web page.

e-mail method

send e-mail to *isttrbl@eoc.ecs.nasa.gov*.

EOC will send back disposition.

Remedy Login

Use Netscape and go to: http://grizzlys/ars/cgi-bin/arweb

login with username and password

Trouble Ticket Login

There are two levels of users that can log into the Trouble Ticket system, Administrator and User. Depending on which level user is logged in the screens will be different.

Query or Submit for Administrator

The administrator has permissions to all schemas so you must click on the circle in front to Trouble Ticket before query or submit.

User Submit or Query

There are two selections a user can make:

Query: used to check on the status of an existing Trouble Ticket.

Submit: used to insert a new Trouble Ticket into the system

Query Trouble Ticket

This screen is the same for both users the outcome of the query will be different depending on type of user.

User Query Result Screen

This screen is the result of a user querying for an existing Trouble Ticket. The option the user has is to display the ticket by clicking in the entry id.

Administrator Query Result

This query result screen is used to modify or display and existing Trouble Ticket.

Modify Existing Trouble Ticket

This screen is used by an administrator to modify an existing Trouble Ticket.

An FOT Administrator can also modify the Trouble Ticket.

When a Trouble Ticket is received the Administrator and reviewing committee are notified (e-mail or pager).

Summary

Current

send e-mail to EOC using template.

EOC will evaluate and send back disposition.

Future

submit Trouble Ticket via the Remedy web page

check status via the query option on web page

Where to get more information

Contact

Michael Arnold

301-614-5018

marnold@eoc.ecs.nasa.gov

Abbreviations and Acronyms

ADAC	Attitude Determination And Control
ALE	Activity Log Entry
AOS	Acquisition of Signal
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
ATC	Absolute Time Command
CAC	Command Activity Coordinator
CCB	Configuration Control Board
CCR	Configuration Change Request
CI	Configured Item
CM	Configuration Management
CMS	Command Management System
COTS	Commercial off the Shelf
CRC	Cyclic Redundancy Check
DAAC	Distributed Active Archive Center
DAS	Detailed Activity Schedule
DB	Database
DBA	Database Administrator
DFCD	Data Format Control Document
DR	Discrepancy Report
DS	Data Server
EBnet	EOSDIS Backbone Network
ECS	EOSDIS Core System
EDOS	EOS Data and Operations System
EGS	EOS Ground System
EOC	EOS Operations Center
EOS	Earth Observing System

EOSDIS	EOS Data and Information System
EPGS	EOS Polar Ground Station
ER	Equipment Room
ETS	EOSDIS Test System
FDF	Flight Dynamic Facility
FDD	Flight Dynamics Division
FDIR	Fault Detection, Isolation, and Recovery
FOD	Flight Operations Director
FOS	Flight Operations Segment
FOT	Flight Operations Team
FSW	Flight Software
GOE	Ground Operations Exercise
GSFC	Goddard Space Flight Center
GSIF	Ground Station Interface Facility
HGA	High Gain Antenna
HK	housekeeping
HRS	High Rate System
I&T	Integration and Test
ICC	Instrument Control Center
IGSE	Integrated Ground Support Equipment
IPG	Instrument Planning Group
IOC	Instrument Operations Center
IOT	Instrument Operations Team
IS	Integrated Simulation
IST	Instrument Support Toolkit
JPL	Jet Propulsion Laboratory
LAN	Local Area Network
LSR	Launch Support Room
LST	Launch Support Team

LZPF	Level Zero Processing Facility
MAR	Mission Analysis Room
MO	Master Oscillator
MOR	Mission Operations Room
MSR	Mission Support Room
NASA	National Aeronautics and Space Administration
NCC	Network Control Center
NEA	Non-Explosive Activator
NSI	NASA Science Internet
OC	Operations Controller
ODB	Operational Database
ODF	Operational Database Files
ODS	One Day Schedule
OOL	Out of Limits
OV	On-orbit Verification
PAS	Planning And Scheduling
PDB	Project Database
PML	Program Maintenance Library
PRA	Pyrotechnic Relay Assembly
RDBMS	Relational Database Management System
RDD	Return Data Delay
RF SOC	Radio Frequency Simulations Operation Center
RTCS	Relative Time Command Sequence
RTS	Real-Time Server
SC	Simulation Coordinator
SCC	Spacecraft Control Computer
SDVF	Software Development and Verification Facility
SN	Space Network
SOE	Spacecraft Operations Exercise

SOP	Standard Operating Procedures
SS	Shift Supervisor, Simulator Specialist
SSER	Simulation and Sustaining Engineering Room
SSIM	Spacecraft Simulator
SSR	Solid State Recorder
ST	Simulation Team
STS	Short Term Schedules
STC	Simulations Training Conductor
TDRS	Tracking and Data Relay Satellite
TGT	TDRSS Ground Terminal
TMON	Telemetry Monitor
TONS	TDRS On-board Navigation System
USCCS	User Spacecraft Clock Calibration System
UT1	Universal Time 1
UTC	Universal Time, Coordinated
WOTS	Wallops Orbital Tracking Station
VF	Valley Forge